

DEQ-AAC Meeting
Virginia Department of Forestry Building (Board Room)
Charlottesville, VA
May 24, 2016

Meeting notes by Jane Walker

Department of Environmental Quality (DEQ) Personnel Present

Alex Barron
Rick Browder
John Kennedy
David Whitehurst

AAC Members Present

Fred Benfield, Virginia Tech
Drew Garey, Virginia Commonwealth University (VCU)
Greg Garman, VCU
Kevin McGuire, Virginia Tech
Daniel McLaughlin, Virginia Tech
Stephen Schoenholtz, Virginia Water Resources Research Center (VWRRC), Virginia Tech
Kurt Stephenson, Virginia Tech
Jane Walker, VWRRC, Virginia Tech
Gene Yagow, Virginia Tech
Carl Zipper, Virginia Tech

Others Present

Durelle “Scotty” Scott, Virginia Tech
Meredith Steele, Virginia Tech

Introductions and Approval of Agenda

Stephen Schoenholtz called the meeting to order, and everyone introduced himself or herself. The meeting agenda was approved by consensus.

Class VII Blackwater Criteria Report

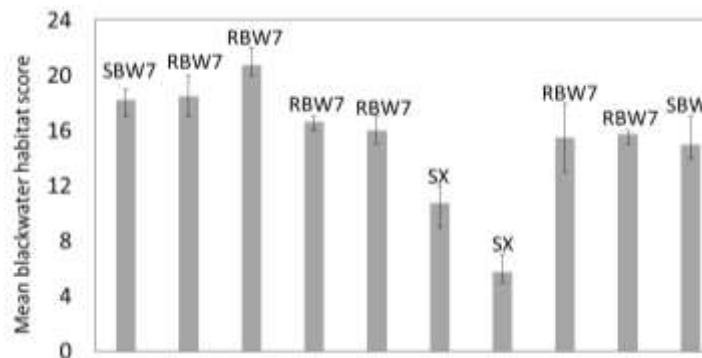
Drew Garey presented a summary of the work thus far accomplished in meeting the project objectives to develop a Blackwater Habitat Protocol (BHP) and Blackwater Condition Index (BCI). Class VII blackwater systems have natural conditions (low pH, low dissolved oxygen levels, etc.) that are stressful to most aquatic life but are inhabited by endemic species that have adapted to the stressful environment. There is a need for an assessment process that recognizes the unique water-quality characteristics and endemic organisms of these systems.

Overall Study Objectives

The BHP is to be a support tool for biologists to determine whether water bodies should be assessed as Class VII waters. The BCI is to serve as an alternative to the Coastal Plain Macroinvertebrate Index (CPMI) to effectively assess impairment in Class VII Swamp waters.

Previous Work

The 2014 AAC report showed that the proposed BHP is highly effective for separating swamps (Class VII) from non-Class VII waters, however, it is less effective for separating true “blackwater” swamps from other Class VII waters. The working BHP has provided consistent results among five biologists, generally showing that scores <12 are free-flowing streams and those >15 are Class VII waters (see graph below, which was included in the 2014 AAC report; bars show mean BHP scores at test sites, and error bars indicate range of scores among investigators).



The work in 2015 resulted in a preliminary fish-based BCI for Chowan basin swamps. Recommendations from the 2015 efforts, which guided the work in 2016, included the following:

- Focus on the Chowan sites in 2016;
- Conduct field reconnaissance of sites used in the 2015 investigation (BHP and water physicochemistry);
- Refine BCI (use algorithm to evaluate best metric set; refine scoring system);
- Evaluate macroinvertebrate index and compare results with those from the fish index.

FY 2016 Work

The researchers conducted field visits to 29 of 34 sites used in 2015. Five sites were not visited due to landowner postings, but these sites were included in the study based on past work and best professional judgment. As a result of the BHP study, four sites used in 2015 were excluded (judged as non-Class VII). Thirty-seven sites with existing fish data from the INSTAR Healthy Waters database were added to the database in 2016, resulting in a total of 67 study sites.

The watersheds of the 67 study sites were delineated using ARCGIS, and land cover was quantified using 2011 National Land Cover database (<http://www.mrlc.gov/nlcd2011.php>) (30-m resolution). The sites were classified as one of the following:

- Reference sites: > 70 % forest (n = 8)
- Intermediate sites: 50-70% forest (n = 18)
- Altered sites: < 50% forest (n = 41)

The 67 study sites were randomly divided into a model set (about 60% of sites), used for construction of the BCI, and a test set (about 40% of sites), used for model validation. For each model site, the researchers calculated 41 fish metrics commonly used for bioassessment:

- Abundance: catch per unit effort (fish/minute).
- Individual condition: individuals with lesions, tumors, parasites.
- Diversity: richness, evenness, diversity.
- Ecological habit/habitat: feeding guild, blackwater specialization, habitat use.
- Pollution tolerance: species especially sensitive or tolerant to pollution.

Seven metrics were removed because $\geq 50\%$ sites received raw values of 0 for the respective metric. The remaining metrics were scored following Blocksom (2003)¹, also Dail et al. (2013)², and scaled between 2.5 and 97.5 percentiles (to remove outlier effects). The metrics were scaled on a 0-100 point system, with metric scores decreasing in response to impairment.

From the remaining 34 metrics, the researchers found that eight gave the best correlations with the percent forest cover. Thus, an 8-metric index was selected (see below).

<u>Metric</u>	<u>Response to Stress</u>
Opportunist species (%)	Increase
Opportunist species (n)	Increase
Tolerant species (n)	Increase
Omnivore species (%)	Increase
Pielou evenness	Increase
Simpson evenness (natives)	Increase
Blackwater species (n)	Decrease
Vegetation specialists (n)	Increase

The usefulness of the 8-metric index was examined with the set of test sites. The researchers concluded that the working BCI index based on fish community exhibits the following characteristics:

- Responsive to landcover gradient in Chowan Basin.
- Reliable based on independent validation.
- Simpler than and as effective as the preliminary 2015 BCI.
 - 2015 BCI
 - 10 metrics
 - correlation with forest landcover: $r=0.54$
 - 90% correct assignment to altered/reference classes
 - 2016 BCI
 - 8 metrics
 - correlation with forest landcover: $r=0.73$ (model), 0.40 (test)
 - correct assignment 97% (model), 88% (test)
- Not confounded by natural environmental variability (no strong correlations with BHP metrics or watershed area).

¹ Blocksom, K.A. 2003. A performance comparison of metric scoring methods for a multimetric index for Mid-Atlantic Highlands streams. Environmental Management, 31(5), 0670-0682.

² Dail, M.R., Hill, J.R. and Miller, R.D. 2013. The Virginia Coastal Plain macroinvertebrate index. Technical Bulletin WQA/2013-002

Work continues on the project, and a report addendum is expected in July 2016. The addendum will provide the results from the water physicochemistry study. It will also include results from the testing of macroinvertebrate metrics developed using the same methods as used for the fish-based BCI. The performance of the macroinvertebrate BCI will be compared to that of the fish BCI at 11 sites. If the results are promising, collection of macroinvertebrates may be needed at more sites in FY 2017.

Recommendations for FY 2017

The VCU researchers recommended that DEQ biologists further refine and validate the fish-based Chowan BCI. Drew offered to provide assistance as needed but suggested that DEQ take the lead in this next phase of developing the BCI. Data from additional study sites and sampling dates (to compare consistency among seasons, years) should be used to improve the BCI. Through this work, the DEQ biologists can evaluate the effectiveness of the BCI for regulatory assessments.

The researchers also recommended that DEQ develop BCIs for use outside the Chowan basin. They suggest that DEQ can use the index-building framework and database developed for this work. Similar BCIs can be developed from data collected in FY 2012-2014, which includes Class VII waters in the James, Piank tank, and Rappahannock basins. DEQ may find that Protocol A works best for the Chowan and Protocol B works best for swamps outside the Chowan.

Blackwater Report Discussion

John Kennedy offered that DEQ plans to have 1-m resolution landuse data for the Chesapeake Bay Watershed in June 2016 and for the rest of the state by December 2016. The VCU researchers expressed interest in this data and thought it could be useful to DEQ in refining the Chowan BCI and developing BCIs in the other watersheds. Daniel McLaughlin suggested that the study could be repeated with the new data but look only at the riparian buffer, instead of the percent forest cover for the entire watershed.

John Kennedy asked if there are rare or endangered fish in the blackwater systems of Virginia. The VCU researchers answered that some blackwater swamps in Virginia have black-banded sunfish, which are listed as a state endangered species. The systems also have other species of concern. These fish species tend to be rare because they are limited to waters with acidic conditions. Drew Garey added that the occurrence of fish in blackwater swamps is fairly rare so a system would not be listed as “impaired” just because specific endemic blackwater fish species were not collected during an assessment.

Scotty Scott noted that the CPMI shows variability between seasons. DEQ biologists must use their best professional judgment and knowledge of recent events (e.g., high-water events) to determine if natural events may have impacted the benthic community at a site. Drew Garey proposed that a fish-based index would likely have less variability with the seasons than would one based on the benthic macroinvertebrates. Greg Garman suggested that for both macroinvertebrates and fish, spring is the least stressful season, and fall is the most stressful. Greg added that fall would be a better season to assess blackwater swamps. Introduced fish species would be less likely to survive summer conditions, so fall collections would be more

likely to show sites where changes within the system have occurred that allow it to support introduced species.

Kurt Stephenson asked if differences seen in the current study could be impacted by fish collections that occurred within different seasons. The VCU researchers responded that the fish collections included here were made between the years 2003 and 2013 during the fish-collection season (generally April to October). Drew Garey added that temporal differences, natural biogeography, location to a larger water body, etc. all have the potential to impact the study results. However, when these systems are disturbed, the causes are usually apparent.

Daniel McLaughlin added that given the importance of flow levels, DEQ could study the effects of discharge when it re-examines the work using the new spatial database. Drew Garey stated the new landuse data could be used to help improve the BCI as well as to help establish the BHP.

Gene Yagow asked if Virginia could gain from other states in the region with blackwater systems. The VCU researchers noted that North Carolina bases its assessments on benthic macroinvertebrates but applies their assessment method only in swamps with a specified amount of flow. Maryland does not have enough reference sites so they are looking to Virginia to develop an index and hope to use it.

DEQ personnel concluded that they were happy with the work performed thus far and asked if the VCU researchers would be willing to focus on the brownwater swamps in the coming year. They also asked if Drew would be willing to help out with the annual meeting of the DEQ biologists.

The VCU biologists noted that DEQ has data that the VCU researchers have not examined, including DEQ probabilistic monitoring data and other data collected by DEQ biologists in the Coastal Plain. These data could be useful in future work.

The meeting participants recommended that the following information be included within the report to aid in its interpretation:

- Raw fish data for the 67 sites;
- Names and latitude/longitude coordinates for each site; and
- Figure 4 from the FY 2014 report showing the degree of agreement among investigators regarding the blackwater habitat scores.

Numeric Nutrient Criteria Report

Carl Zipper provided a presentation on the screening approach being recommended by the AAC and the work accomplished in FY 2016. He offered that the AAC supports development of nutrient criteria for streams and rivers using an effects-based approach, considering the following:

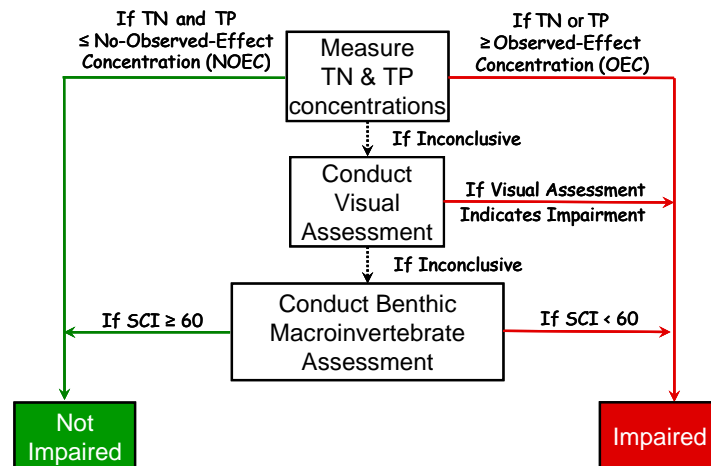
- Designated uses and criteria: components of water quality standards;
- Role of nutrients in aquatic ecosystems (including differences among systems in tolerance for nutrient inputs);
- The pervasiveness of excess nutrients in human-inhabited landscapes.

Carl added that we want to minimize the type I and type II errors associated with an assessment.

The overall goal is to investigate the potential to establish nutrient criteria using a screening approach (see process diagram below). The first step in the process relies on measurement of nutrients and thresholds, called observed-effect concentrations (OECs) and no-observed-effect concentrations (NOECs).

OECs are concentrations for total nitrogen (TN) and total phosphorus (TP) above which nutrient impairment of the aquatic community can be reasonably expected. Under the nutrient criteria screening approach, monitoring sites with measured TN and/or TP concentrations greater than or equal to a corresponding OEC would be assessed as “impaired.”

Freshwater streams with TN and TP concentrations below NOECs would have a low probability of being impaired by nutrients. If DEQ were to adopt nutrient criteria that incorporate a screening approach, as recommended by the AAC (2012a³ and 2012b⁴), freshwater streams with TN and TP concentrations below the NOECs and would be assessed as “not impaired by nutrients.”



The objectives of this year’s AAC tasks included the following:

1. Estimate observed-effect concentrations (OECs) using analysis methods analogous to DEQ assessment process.
2. Estimate no-observed-effect concentrations (NOECs) on an ecoregion basis with updated data.

OEC Development

Carl Zipper investigated the potential to establish OECs through an analysis using the “probability of impairment at equal-or-greater concentrations.” He applied the analysis to DEQ monitoring data using procedures that are analogous to DEQ assessments.

³ Academic Advisory Committee (AAC). 2012a. A “Screening Approach” for Nutrient Criteria in Virginia. July 2012 report to Virginia Department of Environmental Quality.

⁴ Academic Advisory Committee (AAC). 2012b. Technical and Policy Considerations and Options in Assessing Nutrient Stresses on Freshwater Streams in Virginia. December 2012 report to Virginia Department of Environmental Quality.

The analysis used the following datasets:

1. EDAS: DEQ biological monitoring + habitat evaluations
2. Ambient water monitoring: TN and TP as measured or as calculated by Roger Stewart (DEQ).

The EDAS and ambient dataset were combined to associate Virginia Stream Condition Index (VSCI) scores with TN and/or TP at the same location. The goal is to estimate OECs using a conditional probability method by ecoregion (Mountains, Piedmont). This analysis was performed using 6-year assessment periods: 2003-2008 and 2009-2014, just as DEQ uses for its assessments.

A given location during a given period (2003-2008 or 2009-2014) is a “station/period.” Station/periods are analyzed as if independent. Each station/period with ≥ 10 TN and/or TP observations was assigned a concentration that would meet the “10 percent rule” (TPR) for TN and/or TP as appropriate (e.g., for 10-19 observations: 2nd highest value; for 20-29 observations: 3rd highest concentration). If a station/period had <10 observations, Carl did not calculate a TPR value.

Carl Zipper also applied a “hypothetical assessment” (H-assessments) for each station/period using a process similar to that applied by DEQ (as explained by Dr. Tish Robertson with DEQ). For one part of the study, he only included site data with VSCI scores indicating a hypothetical failing (impaired) assessment, and for a second analysis, he included station/periods with either hypothetical assessments of “impaired” or “indeterminate.” From the resulting datasets, he generated impairment probability curves using a conditional probability method (Paul & McDonald 2005). He used LOWESS spline fits to interpolate estimated OEC values associated with the 70%, 80%, and 90% probabilities of H-impairment (see Table 2-2).

Table 2-2. Potential OEC values generated by the methods described, and compared to AAC (2012a) results.

	H-Impaired TN (mg/L), TPR	H-imp & H-Indet TN (mg/L), TPR	AAC (2012), Ambient TN (mg/L)	AAC (2012), Probabilistic TN (mg/L)
Mountains				
70%	5.0	5.0		
80%	5.4	5.4		
90%	6.0	5.9	n/a	3.2
Piedmont				
70%	1.6	1.6		
80%	1.9	1.9		
90%	3.1	3.1	1.8	1.9
	TP (mg/L), TPR	TP (mg/L), TPR	TP (mg/L)	TP (mg/L)
Mountains				
70%	0.70	0.70		
80%	0.80	0.80		
90%	0.90	0.90	n/a	0.26
Piedmont				
70%	0.21	0.04		
80%	0.33	0.19		
90%	0.46	0.45	0.15	0.22

Carl stated that the analysis using station/periods with ≥ 10 observations during 6-year periods generated results roughly comparable to earlier AAC (2012a) results. Although successful in generating potential OECs for the Mountains and Piedmont ecoregions, the results would be difficult to defend. The OECs generated appeared to be high and thus of limited utility.

Furthermore, Carl explained that there are questions concerning application of the “10 percent rule” concept to nutrient criteria because nutrients do not act as direct toxicants.

Numeric Nutrient Criteria Discussion

DEQ personnel mentioned that their 2014 assessment (covering 2007-2012) was recently approved by EPA.

DEQ personnel noted that this work aims at protecting the aquatic life use of streams. The aquatic life use is thought to be the most sensitive use. Their expectations are that if the most sensitive use is protected, all uses will be protected.

DEQ has recently been working on local impairment concerns related to the recreational use in the Shenandoah River. The concerns are based on the amount of filamentous algal in sections of the river. At this time, DEQ has neither criteria for algae coverage thresholds that constitute “nuisance” conditions, nor a method to assess attainment of the recreational use. It intends to have listing thresholds for the recreational use by 2018. As part of this effort, they are considering the results of public perception studies conducted in West Virginia and applied in that state to protect the recreational use. DEQ has also hired two wage employees to collect algae coverage data this summer and field-test methods that are scientifically-based, reproducible, and valid. DEQ may seek recommendations from the AAC for ways to address protecting the recreational use in future workplans.

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The meeting broke for lunch.

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NOEC Development – Probabilistic Monitoring Data

The objective of this task was to investigate the potential to establish NOECs through a “reference filtering” approach using probabilistic monitoring data. For this task, Carl Zipper obtained an updated Probmon database from DEQ and analyzed its 2010-2012 observations to identify new nutrient-criteria references using a method similar to that used in 2012. Twenty-five new reference sites were added to those from the 2001-2009 data (included in the 2012 AAC report). Carl noted that the new data provided were means of (spring + fall) Probmon observations, whereas the 2001-2009 data were single observations.

The combined nutrient-criteria reference dataset was analyzed in an effort to extract NOECs, however, the regression approach was not successful. Thus, Carl defined the 90th and 75th percentiles for each ecoregion from the Probmon nutrient-criteria reference dataset with VSCI scores >60 (not impaired). In this way, he developed potential NOEC estimates for the Mountains and Piedmont ecoregions (see below).

90th Percentiles of Probmon Reference:

Ecoregion	TN (mg/L)	TP (mg/L)
Mountains	0.59	0.028
Piedmont	0.62	0.054

75th Percentiles of Probmon Reference:

Ecoregion	TN (mg/L)	TP (mg/L)
Mountains	0.39	0.020
Piedmont	0.54	0.045

Carl Zipper provided the following summary:

- Method of deriving 90th percentile from non-impaired distributions as potential NOEC estimates appears logical and defensible.
- Scientific rationale for confining that analysis to nutrient-criteria reference dataset is unclear (original intent was to use regression approach within that dataset)
- Method is consistent with EPA-recommended reference approach – although the definition for the reference is not as rigorous (EPA calls for using pristine streams).
- Limited observations per-site and limited site numbers (esp. for Piedmont) are concerns.
- Since additional reference screens attempted by AAC (2012a) did not work as intended, there is no reason to confine this form of analysis to the Probmon dataset.

NOEC Development – Full Dataset

The goal of this task was to extend the NOEC analysis method used to analyze the Probmon dataset to the full dataset (from the OEC analysis). Nutrient-criteria reference station/periods were identified as before (except that the <5% urban land-use filter was not applied). The NOEC analysis methods described above were then applied to the resulting dataset. As with the other NOEC analysis, the regression approach did not yield useful results. Thus, for each ecoregion the 90th and 75th percentiles of TN and TP data were calculated for the subset with VSCI scores >60 (not impaired) using the following: (1) the median values from all identified passing reference sites in the dataset (see below), (2) the median values for passing sites with ≥ 10 observations, and (3) the TPR values for passing sites.

90th Percentiles of H-Not Impaired Reference Distributions (Full dataset):

Ecoregion	TN (mg/L)	TP (mg/L)
Mountains	0.49	0.035
Piedmont	0.73	0.051

75th Percentiles of H-Not Impaired Reference Distributions (Full dataset):

Ecoregion	TN (mg/L)	TP (mg/L)
Mountains	0.375	0.02
Piedmont	0.485	0.04

Carl Zipper summarized the results of applying the NOEC analysis method to the full-dataset, noting the following:

- The results were similar to those generated for the Probmon dataset, but these results are more robust due to increased sample size (n).

- Observations numbers for the subsets with ≥ 10 observations are small, but the median-generated values are similar to those yielded by the “all data” analyses with larger sample size.
- The 90th-percentile TPR values are higher than the corresponding median-generated values but are not robust due to small sample size.

Continuation of Numeric Nutrient Criteria Discussion

Carl Zipper commented that the nutrient-criteria reference (not impaired) dataset, used in developing NOECs, seems to consist of high-quality sites (as based on VSCI scores).

It was proposed that DEQ consider not setting OECs for the Mountains region based on the results of this analysis.

Meredith Steele suggested looking at the combination effects of nutrients, e.g., when nitrogen is plentiful, is phosphorus limiting, etc. Carl Zipper offered that the AAC looked at this in an earlier study and did not find a significant relationship. He offered that a plot could be developed of TN (or TP) on one axis and the ratio of TN/TP on the other axis and plot impaired and not-impaired sites.

Drew Garey questioned if the AAC has examined co-variants enough, given the comments from EPA about the screening approach. He thought an analysis of canopy cover or light availability could be helpful. Kurt Stephenson proposed that the new landuse database could be used to correlate forested 100-ft stream buffers with select data. Drew added that canopy cover estimates from the Rapid Habitat Assessment field sheets could be utilized for rough estimates.

Daniel McLaughlin commented that Florida conducted a study that showed no relationship between nutrients and Florida SCIs (mostly looking at low-order streams).

Fred Benfield noted that not all nitrogen is transported downstream; some leaves as denitrification in shady mountain streams.

Daniel McLaughlin stated that flow is a good predictor of nutrients. During high flows, the nutrients concentrations will be low, and during low flows, the nutrient concentrations will be high. He recommended that flow be measured so that the load of nutrients in the system could be calculated.

DEQ personnel reported results from a DEQ study using its Probmon dataset. This study found a high probability of risk of impairment in streams with TP concentrations > 0.1 mg/L and for streams with TN concentrations > 2.0 mg/L. These results are included in a draft internal document on the benthic stressor identification analysis. AAC members recommended that DEQ consider using these values as OECs once the DEQ report has been finalized. Carl Zipper speculated that the DEQ results are likely more realistic and better to use than the OECs generated in this study by the AAC.

DEQ personnel commented that EPA has found the use of shorter assessment windows to be more protective. Carl Zipper suggested that if DEQ could collect six samples per year at a site

and conduct assessments every two years, they would have more than 10 data points per site. He further recommended that DEQ avoid making impairment designations from one, two, or three data points.

To establish numeric nutrient criteria for the Commonwealth, DEQ needs approval from EPA. Based on EPA's earlier comments, the agency personnel seem to support the screening approach in general. However, DEQ needs to present numeric criteria. It was suggested by an AAC member that DEQ could present the OECs to EPA as Virginia's numeric nutrient criteria. Another AAC member suggested that DEQ could begin by using the cutoffs identified in the DEQ Probmon study (TP: >0.1 mg/L; TN:> 2.0 mg/L). These thresholds would likely identify the top 10% of streams with the highest TN and TP levels. DEQ could then phase in the use of the screening approach – based on the 90th percentiles first, and then phase in the use of the 75th percentiles.

Carl Zipper expressed appreciation to all of the DEQ personnel who helped him.

FY 2017 AAC Tasks

Blackwater Project

For the blackwater project, the DEQ personnel voiced support for the recommendations outlined in the report. They agreed it was time for DEQ biologists to begin refining the index and offered to meet with their biologists to have some internal discussions. Rick Browder asked for clarification on the temporal study to be conducted. Should the biologists consider both seasonal and year-to-year differences? Drew Garey replied in the affirmative for both.

Drew Garey and Greg Garman asked for DEQ's data (Probmon for Coastal Plain and other pertinent data collected by the regional biologists in this region).

DEQ requested to have the final report by June 1, 2016 and the addendum to the report in July. The VCU and DEQ representatives agreed to meet in mid-June to establish tasks for FY 2017. The established tasks for the blackwater project should be submitted to Stephen Schoenholtz around the first of July for inclusion in the proposal.

Numeric Nutrient Criteria Project

To finalize the screening approach report, Carl Zipper offered to address the comments raised by Tish Robertson and others. It was suggested that the report include values for both the 90th and 75th percentiles and reference the possible use of the draft study results obtained by DEQ from its Probmon data (DEQ's Stream Threshold Tool).

John Kennedy requested time to meet with his supervisor, Jutta Schneider, before proposing tasks for FY 2017. He thought a review of the agency's nutrient criteria strategy might uncover items where the AAC could provide assistance. He also mentioned that DEQ may want assistance from the AAC regarding listing thresholds and criteria to protect the recreational use. Carl Zipper suggested that DEQ may want to consider having the AAC review the DEQ stressor identification document for possible recommendations on its use for developing OECs.

Other Comments

Stephen Schoenholtz reminded DEQ personnel of expected changes in the membership of the AAC after next year. Carl Zipper and Gene Yagow plan to retire in the coming year. He also noted that Eric Smith will be back from sabbatical next year.

With no further business, the meeting was adjourned.